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Monitoring Completed Navigation Projects Program

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PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes the U.S. Army Corps of Engineers Monitoring Completed Navigation Projects (MCNP) Program. The program was formerly known as the Monitoring Completed Coastal Projects Program, but was modified in the late 1990s to include all navigation projects, inland as well as coastal.

OVERVIEW: The MCNP Program evaluates the performance of completed civil works navigation projects. Its objective is to obtain information for verifying, or improving, navigation project performance. Monitoring is conducted to (a) determine if the project is functioning as designed, (b) improve design procedures, (c) improve construction methods, and (d) improve operations and maintenance techniques.

Shallow- and deep-draft navigation projects located in rivers, reservoirs, lakes, estuaries, and the coastal zone may be considered for monitoring in the MCNP Program. Monitoring may be conducted as either a comprehensive detailed survey to verify postconstruction conditions on a one-time basis, or a continuous (repetitive) collection of prototype data over an extended period. The MCNP Program can only fund monitoring for completed projects operated and/or maintained by the Corps. Projects must be related to navigation, or mitigation for navigation, to be monitored by the program.

Monitoring of selected projects under MCNP is funded by Headquarters, U.S. Army Corps of Engineers (HQUSACE), from the Operations and Maintenance (O&M) appropriation. HQUSACE has overall responsibility for the program, and the Coastal and Hydraulics Laboratory (CHL), U.S. Army Engineer Research and Development Center (ERDC) provides for day-to-day technical accomplishment and management of the MCNP Program.

Nominations of projects for the MCNP Program are requested by HQUSACE when funds are available for the monitoring of additional projects. Solicitations are sent to Division offices, which solicit and receive nominations from their Districts. Nominated projects are ranked by HQ-established criteria and then prioritized by a Field Review Group during program reviews. Final selections for the program are made at HQUSACE based upon the priority listing, national priorities, and available funds. The regulation governing the MCNP Program is ER 1110-2-8151 (USACE 1997). Monitoring is accomplished as a cooperative effort between ERDC and the District in which the project is located.

MONITORED SITES: Thirty-two project sites have been monitored through the MCNP Program to date, as shown in Figure 1. These projects include coastal sites on the Atlantic, Pacific, Gulf of Mexico and Great Lakes' coasts as well as projects in Alaska, Hawaii, Guam, and Puerto Rico. In addition, since 1999 the performance of inland navigation projects such as locks, dams, and riverine training structures have been monitored. In general, hydrodynamics (waves, tides, currents), sedimentation (erosion, accretion), and/or structural elements of the projects were monitored to determine if they were performing as designed. Most of these projects were monitored intensely over an extended period of time.

Figure 1. Sites of current and completed MCNP projects monitored

One work unit in the MCNP Program, "Periodic Inspections," entails monitoring projects on a periodic basis. Projects are monitored at a low level periodically to add to the Corps' understanding of the long-term response of a particular structural design to its environment. Structures are generally monitored through low-cost remote sensing methodology (photogrammetry). Base level data are initially obtained and the projects are revisited periodically to determine changes that may have occurred. Sites monitored through periodic inspections are shown in Figure 2.

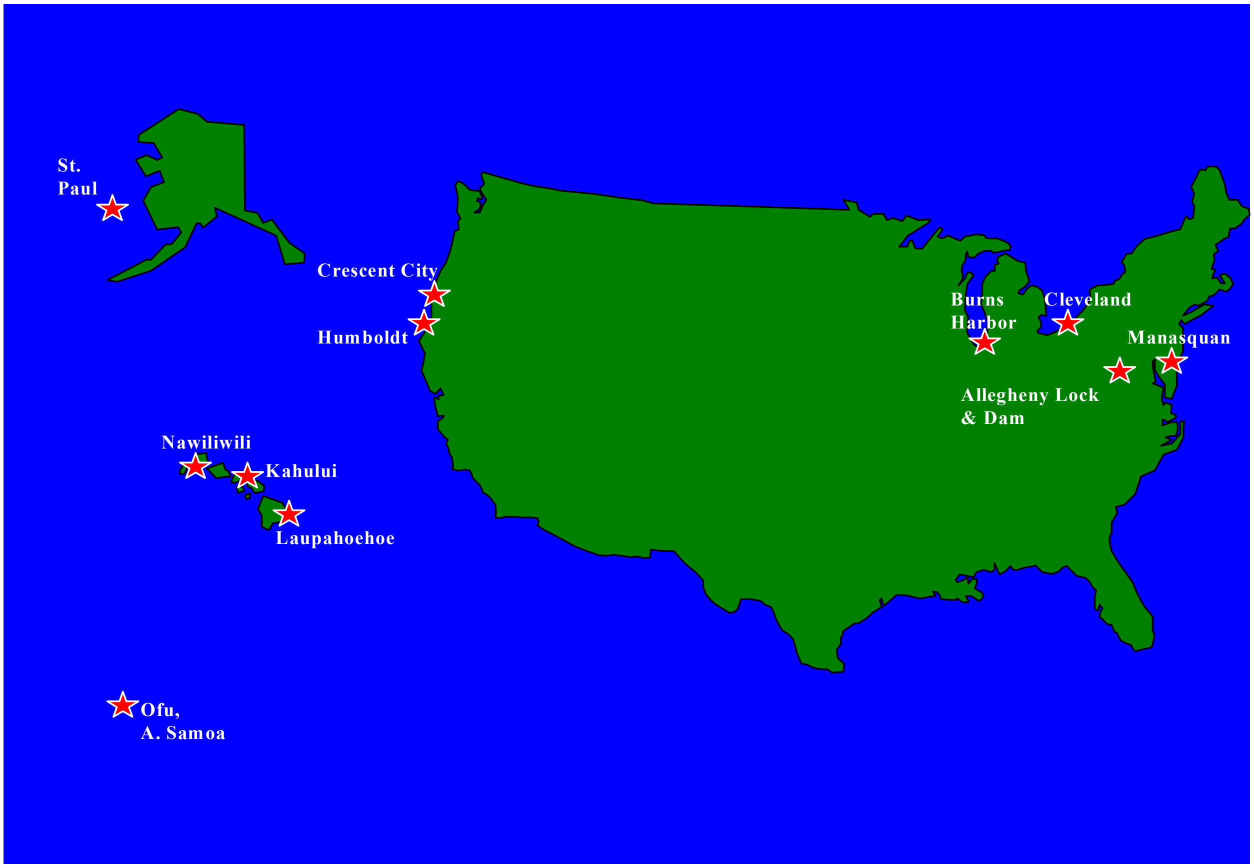

Figure 2. Sites monitored through periodic inspections

CURRENT PROJECTS: There are currently eight active projects being monitored in the MCNP Program. Brief descriptions of these projects are presented in the following subparagraphs:

Morro Bay Harbor, California. The entrance to Morro Bay was known as one of the most dangerous in the United States due to steep and breaking wave conditions. Improvements completed in December 1995 consisted of a deepened, expanded entrance channel and a sand trap within the harbor entrance structures. Modifications were expected to allow passage of most large waves through the entrance without breaking, or steepening, and creating hazardous conditions. Structural modifications at the site lacked economic justification. Prior to improvements, both numerical and physical model investigations were conducted as well as a limited field investigation to optimize project design performance.

The objective of the monitoring study is to determine if the nonstructural modifications at the harbor entrance are performing as predicted. Evaluation of hydrodynamic conditions and sedimentation rates in the harbor entrance as well as validation of models used as design tools are being performed. Wave data (both inside and outside the harbor entrance), tidal elevations and currents, and bathymetric surveys are being obtained to determine design effectiveness of the harbor entrance alternative. Limited ground surveys and photogrammetric surveys of the existing south breakwater are also being obtained to determine if any negative impacts to the structure have occurred as a result of the dredging improvements.

Marseilles Dam, Illinois. At Marseilles Dam navigation pools must be maintained within narrow limits to prevent overtopping of fully closed tainter gates and to maintain adequate depths in the shallow navigation channel. Prior to the 1989 installation of a remote operation system, Marseilles Lock and Dam was attended 24 hours a day because the lock and dam are 3.86 km (2.4 miles) apart. Also, prior to the installation of submersible tainter gates, ice often built up on the structural members of the nonsubmersible gates and froze them in place. The old gates were not designed to pass ice without being raised nearly wide open, which adversely affected the pool and created scour downstream. Submersible gates in the past have had a tendency to vibrate, possibly causing structural damage to dams and gates. Prior to installation of the submersible tainter gates, a physical model investigation was conducted to determine vibrations for various gate submergences.

The objective of the monitoring study is to determine if the remote operation system and submersible tainter gates are performing as predicted and to determine any operational limitations of these project features. Evaluation of hydrodynamic, scour, and ice flow conditions as well as structural stesses on the submersible tainter gates are being performed. Pool elevations, passage of ice through the submersible gates, downstream scour, and gate vibration data are being obtained to determine design effectiveness.

Tedious Creek, Maryland. Prior to improvements, three docks, a boat ramp, and mooring areas adjacent to the channel were exposed to severe wave energy that adversely affected navigation and resulted in damages and delays to commercial vessels. The construction of two shore-connected, rubble-mound breakwaters and revetments at the mouth of Tedious Creek was completed in 1997 to protect the harbor from damaging waves. Gaps were incorporated into the breakwaters to improve tidal circulation. Poor foundation material beneath the south breakwater was dredged and backfilled with pea gravel, and the dredged material was beneficially used to stabilize an adjacent eroding shoreline with geotextile tubes used to contain the material. This area was planted with marsh vegetation.

The objective of the monitoring study is to evaluate the effectiveness of navigation improvements in Tedious Creek Harbor from the standpoint of wave attenuation, tidal circulation, sedimentation, and wetland impacts. The effectiveness of multidimensional modeling tools used to design the project is also being evaluated relative to their accuracy and productivity. Monitoring activities include the collection of wind, wave, current, tide, and bathymetry data in the vicinity of the harbor to determine design effectiveness. The hydraulic stability of the breakwater is also being evaluated.

Boston Harbor Confined Aquatic Disposal (CAD) Cells, Massachusetts. Navigation improvements at Boston Harbor involve deepening tributaries of the Inner Harbor and associated berthing areas. Lack of an upland disposal site and resource agency denial of permission to place contaminated sediments in an open water site has resulted in the decision to use in-channel CAD cells for placement of contaminated material dredged with an environmentally sensitive clamshell bucket. This is the first application of in-channel CAD cells.

The objective of the monitoring is to complement scheduled monitoring with supplementary monitoring that will help evaluate the effectiveness of in-channel CAD cells at Boston Harbor. Water quality monitoring of suspended solids is being conducted near the operation of two environmentally sensitive clamshell buckets and a normal clamshell bucket to document the benefits of the special buckets. The amount of water being added with each bucket type is also being monitored since added water has an impact on the strength and density of the contaminated material which influences its ability to support a cap. The contaminated dredged material consolidation and strength prior to and after placement of the sand cap is being monitored. Laboratory experiments are being conducted to measure consolidation, shear strengths, water content, etc, of the contaminated sediments and the Boston blue clay to refine predictive techniques for mound and cap performance. In addition, cap erosion predictions from both tidal currents and ship prop wash are being measured and calculated to characterize the amount of cap damage expected from either source. This information will be valuable to others considering either in-channel CAD or conventional CAD sites.

Tom Bevill Lock and Dam, Alabama. After construction of the Tom Bevill Lock and Dam, navigation problems were experienced with crosscurrents in the upper lock approach. As a result of float studies, a rock deflector dike was constructed upstream on the east side of the channel. It was successful in abating crosscurrents for low flows, however, the problem still existed when significant spillway releases were made upstream. A physical model study was conducted to determine improvements required for the alleviation of crosscurrents in the upper lock approach that recommended an extension of the guide wall in the upper approach and removal of a portion of the rock dike.

The objective of the monitoring effort is to determine if the guardrail extension and shortening of the rock dike will result in a functionally effective lock approach as predicted. Monitoring will evaluate flows in the upper lock approach and will include the collection of videography, current data, bathymetric data, Global Positioning System (GPS) tow track measurements, pool elevations, and gate openings at the project site. The head differential of the guard wall will also be monitored. Information will be gathered for various discharges.

Aguadilla Harbor, Puerto Rico. The Aguadilla coastline is exposed to direct wave attack from the northwest and indirectly from diffraction of waves from other directions. Prior to construction of a breakwater, the local fishery was restricted to the use of small flat-bottomed boats that could easily be hauled onto the limited beach front when not in use due to their inability to pass through the breaker zone. Construction of a 304.8-m- (1,000-ft-) long rubble-mound breakwater was completed in 1995, which afforded commercial fisherman the only protected harbor along a 50-mile stretch of shoreline. During and following construction, shoaling of a segment of the harbor was observed. Subsequent to completion, additional shoaling was observed with limited wave activity.

The objective of the monitoring study is to study the harbor shoaling and effectiveness of the breakwater on hydrodynamics in the harbor. Data is being obtained to determine the causes of shoaling in the harbor and validate the effectiveness of the project design. Monitoring activities include beach profiling north and south of the harbor and hydrographic surveys within the harbor itself. Additionally, wave height and current data are being obtained nearshore and within the harbor. The data is being utilized to determine the nearshore processes contributing to potential shoaling. Wave height data is also being used to evaluate the success of the breakwater with regard to wave height reduction. The hydraulic stability of the breakwater is also being evaluated.

Upper Mississippi River Navigation Structures. Most training structures on the Mississippi River were constructed over 100 years ago. Subsequent construction of locks and dams submerged these structures which reduced their effectiveness and increased river-floodplain connectivity. Both training structure submergence and river-floodplain connectivity are a function of longitudinal pool position. Course sediment transport also varies because of the longitudinal changes in submergence. A drawdown is being performed in Pool 8 to expose mudflats, cause seed germination, and benefit fish and wildlife. In Pool 8, most dredging is done in the middle of the reach of the pool between river mile (RM) 691 and 688, where a combination of training structure submergence, floodplain conveyance, and coarse sediment availability results in river deposition. It is unknown how the flow and sediment movement in the vicinity of these structures will change during such a drawdown. In addition, training structures in Pool 22 have recently been rehabilitated upstream of a lock and dam to maintain sufficient navigation depth in the approach to the lock. The renovation was both numerically and physically modeled and construction was completed in 1995.

The objectives of the monitoring effort are to evaluate hydrodynamic and sediment transport processes before, during, and after the drawdown at Pool 8 as well as to evaluate the effectiveness of the training structures in maintaining the channel in Pool 22. Monitoring at both sites includes measurements to determine bathymetry changes, and to determine hydrodynamic sediment transport changes. Suspended sediment samples and bed-load measurements also would be obtained and analyzed. Monitoring is expected to improve the Corps predictive capability and result in a more technically based, cost-effective, and ecologically sound management of the Upper Mississippi River navigation system as well as other river systems.

Periodic Inspections. As previously stated, navigation structures are monitored in this work unit on a periodic basis to gain a better understanding of their long-term responses to the environment. Currently three project breakwaters in the Hawaiian Islands are being monitored. These include breakwaters at Nawiliwili Harbor, Kauai; Kahului Harbor, Maui; and Laupahoehoe, Hawaii. All these structures' primary armor layers are compromised of concrete armor units. Base conditions were initially obtained for Kahului and Laupahoehoe breakwaters in 1993 and Nawiliwili breakwater in 1995. Nawiliwili breakwater was constructed in 1922 and has a long history of repair. Breakwater armor consists of 9,979.03- and 20,865.25-kg- (11- and 23-ton) dolosse and 5,896.70- and 16,147-89-kg- (6.5- and 17.8-ton) tribars. The breakwaters at Kahului were initially constructed in 1900 and have undergone numerous repairs and rehabilitations as well. The armor layers consist of 5,443.10-, 18,143.69-, and 27,215.54-kg- (6-, 20- and 30-ton) dolosse, 5,896.70-, 8,164.66-, 9,979.03-, 17,236.51-, 22,679.62-, 31,751.47-, and 45,359.24-kg (6.5-, 9-, 11-, 19-, 25-, 35-, and 50-ton) tribars, and 29,937.1-kg (33-ton) tetrapods. The Laupahoehoe structure was completed in 1990 and includes 27,215.54-kg (30-ton) dolos armor layers.

Monitoring of the Hawaiian breakwaters includes limited ground surveys for control and a photogrammetric survey of the above-water armor layers. Precise positions of all armor units in the photography are analyzed. In addition, representative units are targeted, and x, y, and z coordinates of the targets are obtained and compared with base level conditions to define armor unit movement data. Armor unit centroid data and rotational angles are also computed depicting change. Monitoring also includes detailed broken armor unit surveys for comparison with base conditions.

TECHNOLOGY TRANSFER/INFUSION: Efforts to improve technology transfer/infusion are underway. To date, 39 technical reports and 17 technical notes (including four lessons-learned technical notes) have been published and distributed to the field. In addition, many journal articles and conference proceedings have been published on navigation projects based on monitoring results.

An MCNP Web site has recently been developed and placed on the World Wide Web. The MCNP homepage is shown in Figure 3 and includes a description of the program with various links as shown. The site can be accessed at:
http://chl.wes.army.mil/research/navigation/mcnp_site/default.htm.

Figure 3. MCNP homepage

The MCNP Web site is still under construction. For instance, some MCNP publications can be located via the ERDC Library Web site: *http://134.164.46.9/uhtbin/cgisirsi/iOmd5vxqgv/20555017/503/4042/X/Content/1*. All publications are being scanned and will eventually be accessible in pdf format from the MCNP Web page.

Another initiative underway in the MCNP program involves identifying project benefits derived from lessons-learned and increasing the application of lessons-learned to other projects. Lessons-learned from site-specific projects have been identified as well as generic lessons-learned for various geographical areas. This initiative is being accomplished through pull and push technology transfer/infusion efforts. In pull technology transfer, each District involved in past and present MCNP projects is being surveyed to determine how lessons-learned (from both their projects and other projects outside the District) are being applied to other projects in their District. District personnel are being asked to identify benefits obtained at past projects and to project benefits for present/future projects. In push technology transfer, planned new navigation projects, major rehabilitations, and major periodic O&M efforts are being examined for possible applications of lessons-learned through monitoring of past projects.

ADDITIONAL INFORMATION: Questions relative to this CHETN may be addressed to Mr. Robert R. Bottin, Jr., MCNP Program Manager, at (601-634-3827), FAX (601-634-4827), or e-mail: *bottinr@wes.army.mil*. Additional information may also be obtained from the MCNP Web site at: *http://chl.wes.army.mil/research/navigation/mcnp_site/default.htm*. This Technical Note should be referenced as follows:

> Bottin, R. R. (2001). "Monitoring completed navigation projects program," Coastal and Hydraulics Engineering Technical Note CHETN-IX-5, U.S. Army Engineer Research and Development Center, Vicksburg, MS. *http://chl.wes.army.mil/library/publications/chetn/*

REFERENCE:

U.S. Army Corps of Engineers. (1997). "Monitoring completed navigation projects," Engineering and Design, Regulation No. 1110-2-8151, Washington, DC.